

Claims

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1. A gas sampling system, comprising:  
a plurality of diluters arranged in a serial  
5 array along an axial extent;  
a source of dilution air fluidically  
connected to each one of said plurality of serially  
arranged diluters so as to supply dilution air into  
each one of said plurality of serially arranged  
10 diluters such that said dilution air is supplied into  
(said gas stream <sup>MM</sup> present within each one of said  
plurality of serially arranged diluters so as to  
progressively dilute said gas stream as said gas  
stream flows through said plurality of serially  
15 arranged diluters; and  
sampling apparatus fluidically connected to  
each one of said plurality of serially arranged  
diluters for obtaining and analyzing a sample of said  
diluted gas stream present within each one of said  
20 plurality of serially arranged diluters.
2. The system as set forth in claim 1  
wherein said sampling apparatus includes a scanning  
mobility particle sizer.  
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3. The system as set forth in claim 1  
wherein said sampling apparatus includes a  
condensation particle counter.
- 30 4. The system as set forth in claim 1  
including a plurality of diluent mass flow controllers  
(DMFCs) disposed fluidically upstream of said

plurality of serially arranged diluters for monitoring the mass flow of dilution air being supplied to said plurality of serially arranged diluters, and at least one total mass flow controller (TMFC) disposed

5 fluidically downstream of said plurality of serially arranged diluters for monitoring the mass flow of diluted air stream flowing through said plurality of serially arranged diluters.

10 5. The system as set forth in claim 4 wherein said at least <sup>one</sup> total mass flow controller (TMFC) includes a plurality of total mass flow controllers (TMFCs) fluidically connected respectively to each one of said plurality of serially arranged

15 diluters.

6. The system as set forth in claim 5 wherein each one of said plurality of total mass flow controllers (TMFCs) is operatively associated with a

20 respective one of said diluent mass flow controllers (DMFCs) such that said diluent mass flow controllers (DMFCs) and said total mass flow controllers (TMFCs) are arranged in operative pairs.

25 7. The system as set forth in claim 6 including a calibration valves fluidically connected to each one of said diluent mass flow controllers (DMFCs) and fluidically connected to each one of said total mass flow controllers (TMFCs) so as to permit

30 calibration of each one of said diluent mass flow controllers (DMFCs) with respect to its paired total mass flow controller (TMFC).

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8. The system as set forth in claim 4 wherein each one of said plurality of diluent mass flow controllers (DMFCs) is fluidically connected  
5 directly to a respective one of said plurality of serially arranged diluters.

9. The system as set forth in claim 4 wherein an air dilution manifold is disposed  
10 fluidically upstream of said plurality of serially arranged diluters, and said plurality of diluent mass flow controllers are fluidically connected to said air dilution manifold so as to supply diluent air to said plurality of serially arranged diluters through said  
15 air dilution manifold.

10. The system as set forth in claim 4 including a plurality of calibration valves fluidically connected to each one of said plurality of  
20 diluent mass flow controllers (DMFCs) so as to permit calibration of each one of said diluent mass flow controllers (DMFCs) with respect each other.

11. The system as set forth in claim 4 including a plurality of calibration valves  
25 fluidically connected to each one of said plurality of diluent mass flow controllers (DMFCs) so as to permit calibration of each one of said plurality of diluent mass flow controllers (DMFCs) with respect to each  
30 other and with respect to said at least one total mass flow controller (TMFC).

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12. The system as set forth in claim 11 including a calibration control valve fluidically interposed said plurality of calibration valves and said at least one total mass flow controller (TMFC) for selectively permitting calibration of a particular one of said plurality of diluent mass flow controllers (DMFCs) with respect to said at least one total mass flow controller (TMFC).

10 13. An exhaust gas sampling system for use in connection with the sampling of internal combustion engine exhaust gas streams, comprising:

a plurality of diluters arranged in a serial array along an axial extent;

15 a source of engine exhaust gas fluidically connected to said plurality of serially arranged diluters so as to supply an engine exhaust gas stream into each one of said plurality of serially arranged diluters in a serial manner;

20 a source of dilution air fluidically connected to each one of said plurality of serially arranged diluters so as to supply dilution air into each one of said plurality of serially arranged diluters such that said dilution air is supplied into  
25 said engine exhaust gas stream present within each one of said plurality of serially arranged diluters so as to progressively dilute said engine exhaust gas stream as said engine exhaust gas stream flows through said plurality of serially arranged diluters and thereby  
30 replicate engine exhaust gas stream pollutant atmospheric conditions; and a sampling apparatus fluidically connected to each one of said plurality of

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14. The system as set forth in claim 13 wherein said sampling apparatus has a scanning mobility particle sizer.

15. The system as set forth in claim 13 wherein said sampling apparatus has a condensation particle counter.

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17. The system as set forth in claim 16 wherein said at least one total mass flow controller (TMFC) includes a plurality of total mass flow controllers (TMFCs) fluidically connected respectively to each one of said plurality of serially arranged diluters.

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18. The system as set forth in claim 17 wherein each one of said plurality of total mass flow controllers (TMFCs) is operatively associated with a respective one of said diluent mass flow controllers (DMFCs) such that said diluent mass flow controllers (TMFCs) are arranged in operative pairs.

19. The system as set forth in claim 18 including a calibration valves fluidically connected to each one of said diluent mass flow controllers (DMFCs) and fluidically connected to each one of said total mass flow controllers (TMFCs) so as to permit calibration of each one of said diluent mass flow controllers (DMFCs) with respect to its paired total mass flow controller (TMFC).

20. The system as set forth in claim 16 wherein each one of said plurality of diluent mass flow controllers (DMFCs) is fluidically connected directly to a respective one of said plurality of serially arranged diluters.

21. The system as set forth in claim 16 including an air dilution manifold disposed fluidically upstream of said plurality of serially arranged diluters, and said plurality of diluent mass flow controllers are fluidically connected to said air dilution manifold so as to supply diluent air to said plurality of serially arranged diluters through said air dilution manifold.

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22. The system as set forth in claim 16 including a plurality of calibration valves fluidically connected to each one of said plurality of diluent mass flow controllers (DMFCs) so as to permit calibration of each one of said diluent mass flow controllers (DMFCs) with respect to each other.

23. The system as set forth in claim 16 including a plurality of calibration valves fluidically connected to each one of said plurality of diluent mass flow controllers (DMFCs) so as to permit calibration of each one of said plurality of diluent mass flow controllers (DMFCs) with respect to each other and with respect to said at least one total mass flow controller (TMFC).

24. The system as set forth in claim 23 including a calibration control valve fluidically interposed said plurality of calibration valves and said at least one total mass flow controller (TMFC) for selectively permitting calibration of a particular one of said plurality of diluent mass flow controllers (DMFCs) with respect to said at least one total mass flow controller (TMFC).

25. A method of sampling an exhaust gas from an internal combustion engine comprising the steps of:

positioning a plurality of diluters in a serial array along on axial extent;

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connecting a source of gas fluidically to  
said plurality of diluters supplying a gas stream into  
each one of said plurality of diluters;

5 supplying a source of a dilution air to each  
one of said plurality of diluters, said supply of  
dilution air progressively diluting said gas stream as  
said gas stream flows through said plurality of  
diluters; and

10 sampling said gas stream at each one of said  
plurality of diluters.

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